Diesel engines on the pathway to low impact on local air quality

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AECC
ASSOCIATION FOR EMISSIONS CONTROL BY CATALYST

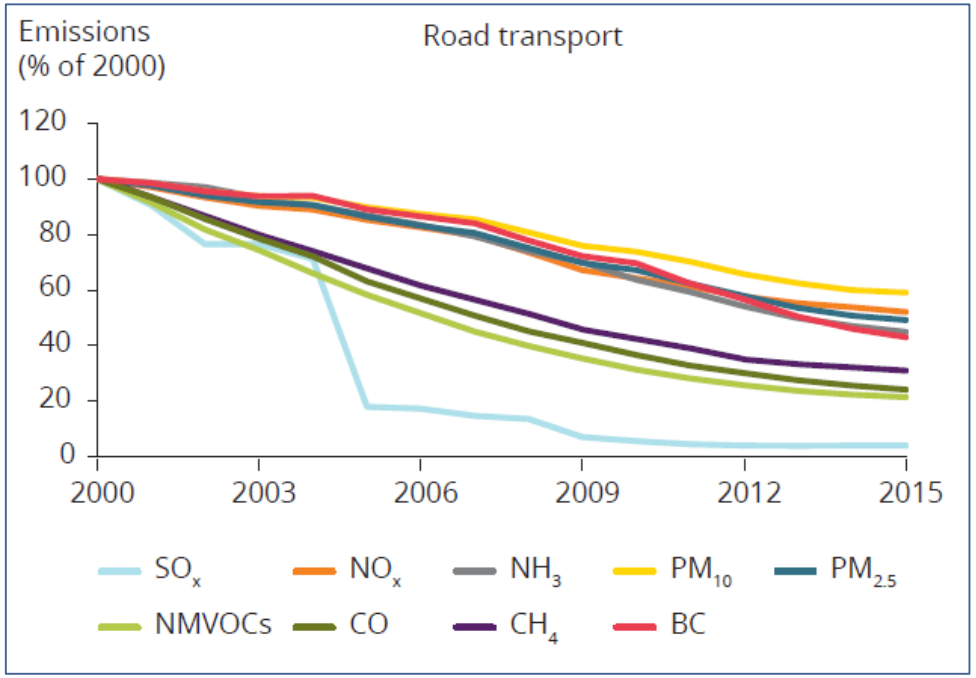
Association for Emissions Control by Catalyst (AECC AISBL)

AECC members : European Emissions Control companies

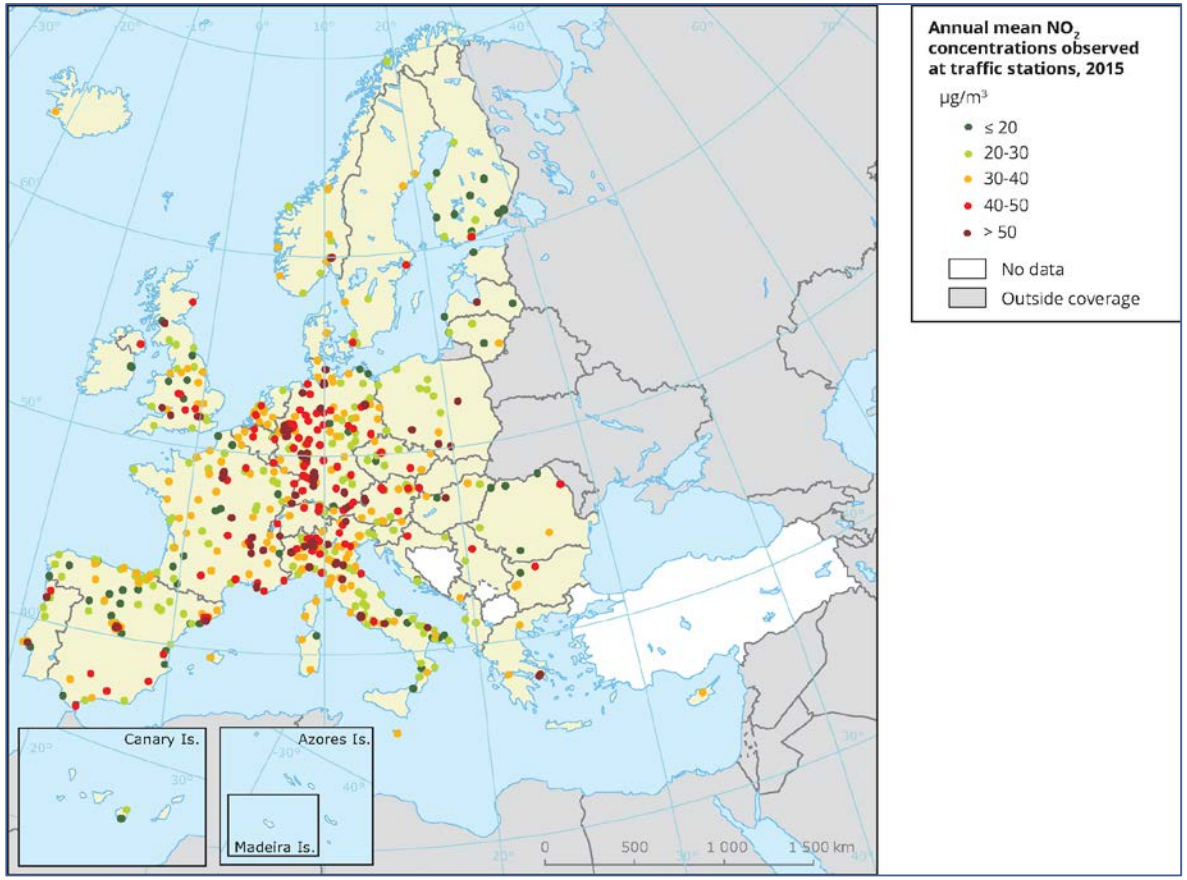
- Exhaust emissions control technologies for original equipment, retrofit and aftermarket for all new cars, commercial vehicles, motorcycles, and non-road mobile machinery

EU Air Quality has improved over the years

But further efforts are needed

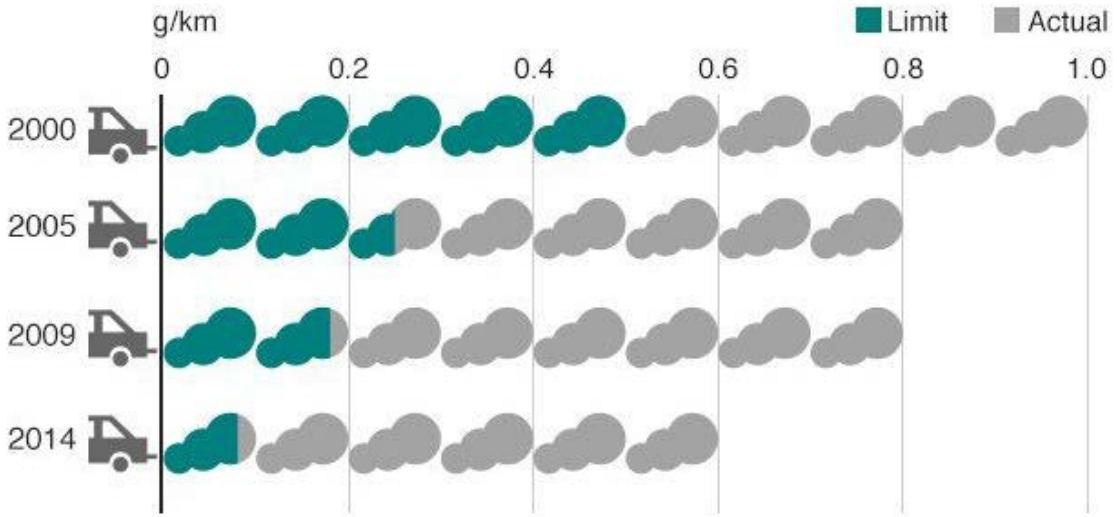


Source: European Environment Agency (EEA)

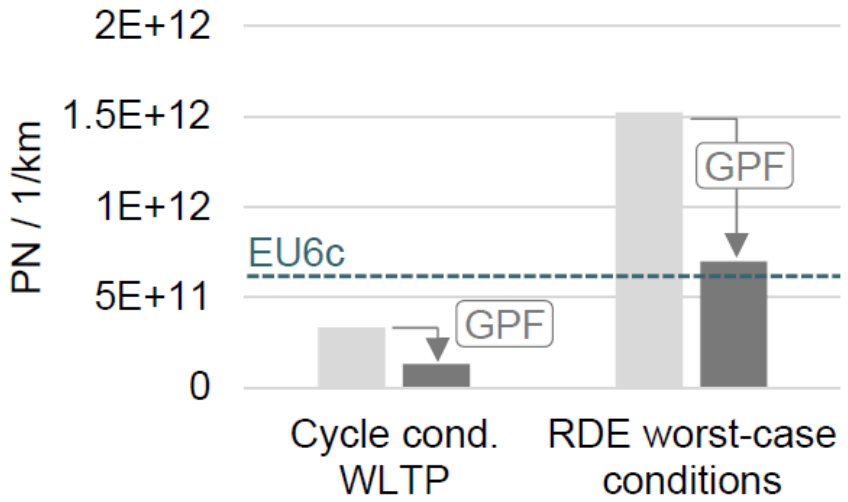


EU RDE legislation introduced as of 1/9/2017

Aims to close the emissions gap between lab and real-world



Source: average on-road diesel NOx emissions, the ICCT



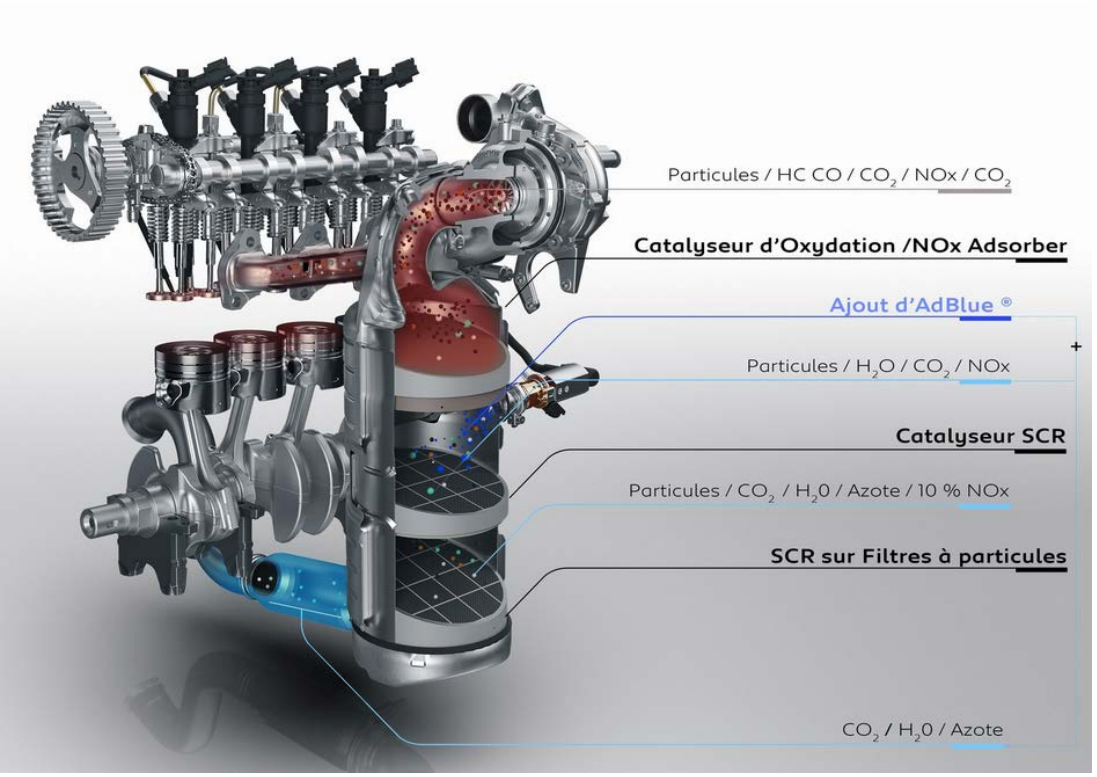
Source: Gasoline Particulate Filters Market and Technology Trends and their Impact on Calibration, FEV, SIA powertrain 2017

Content

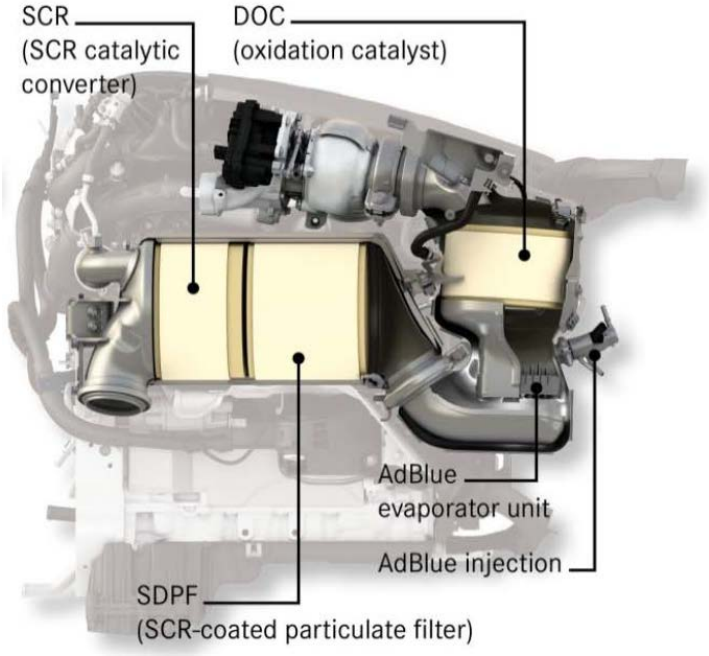
- Evolution in diesel emissions control technologies
- Low NOx emission diesel cars: a reality
- Air quality modelling

Light-duty diesel emissions control technology evolution

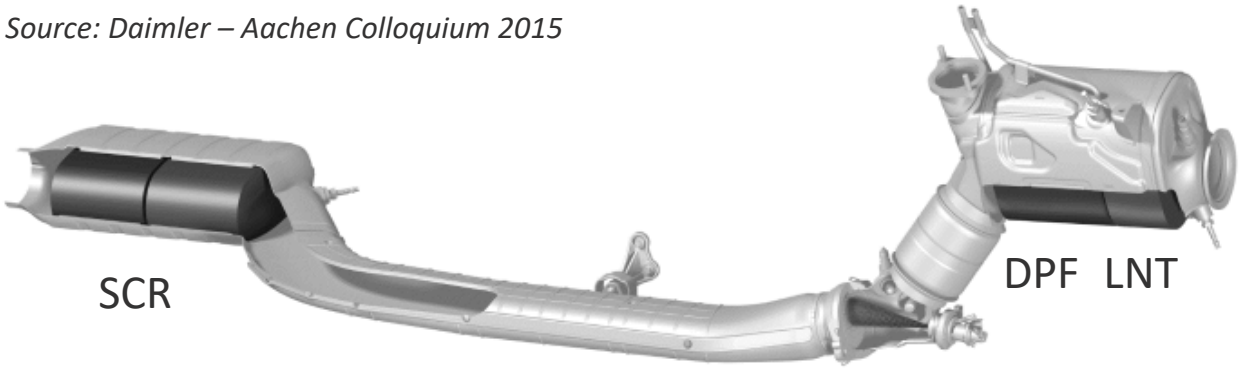
Towards combination of technologies in a compact design for RDE compliance



Source: Peugeot – 308 press release 2017



Source: Daimler – Aachen Colloquium 2015

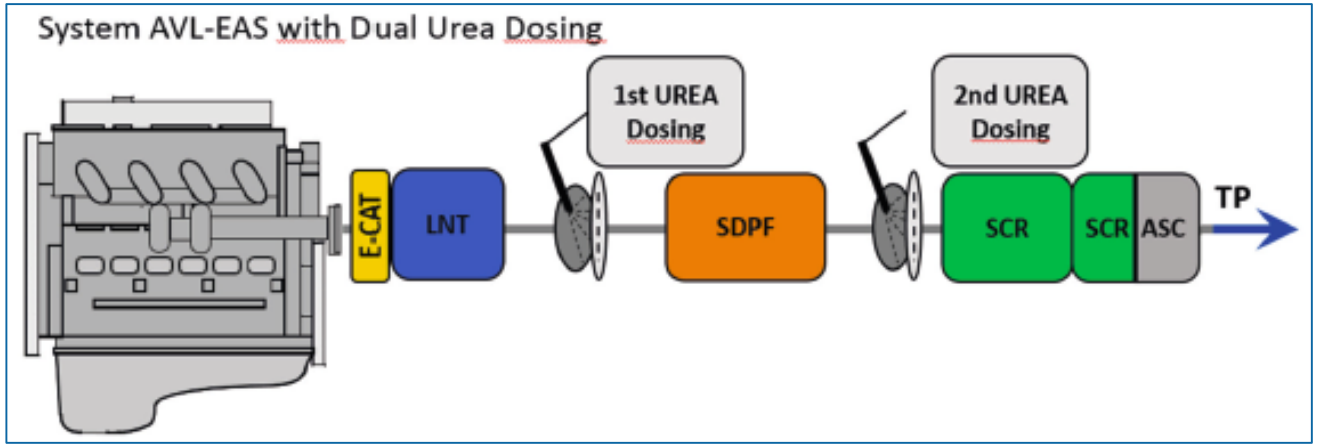


Source: BMW – Aachen Colloquium 2015

Light-duty diesel emissions control technology evolution

Potential for future improvements to cover a wide range of driving conditions

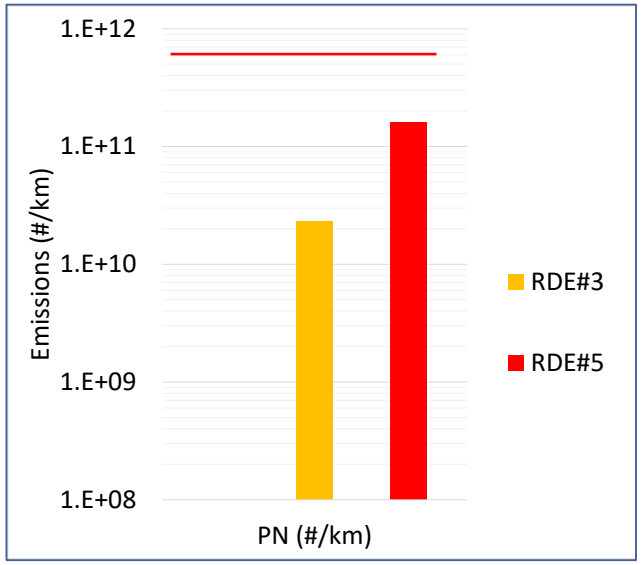
- SCR in different locations to cover urban and motorway driving
- Dual urea injection to provide more flexible dosing
- Optimising thermal management for urban driving

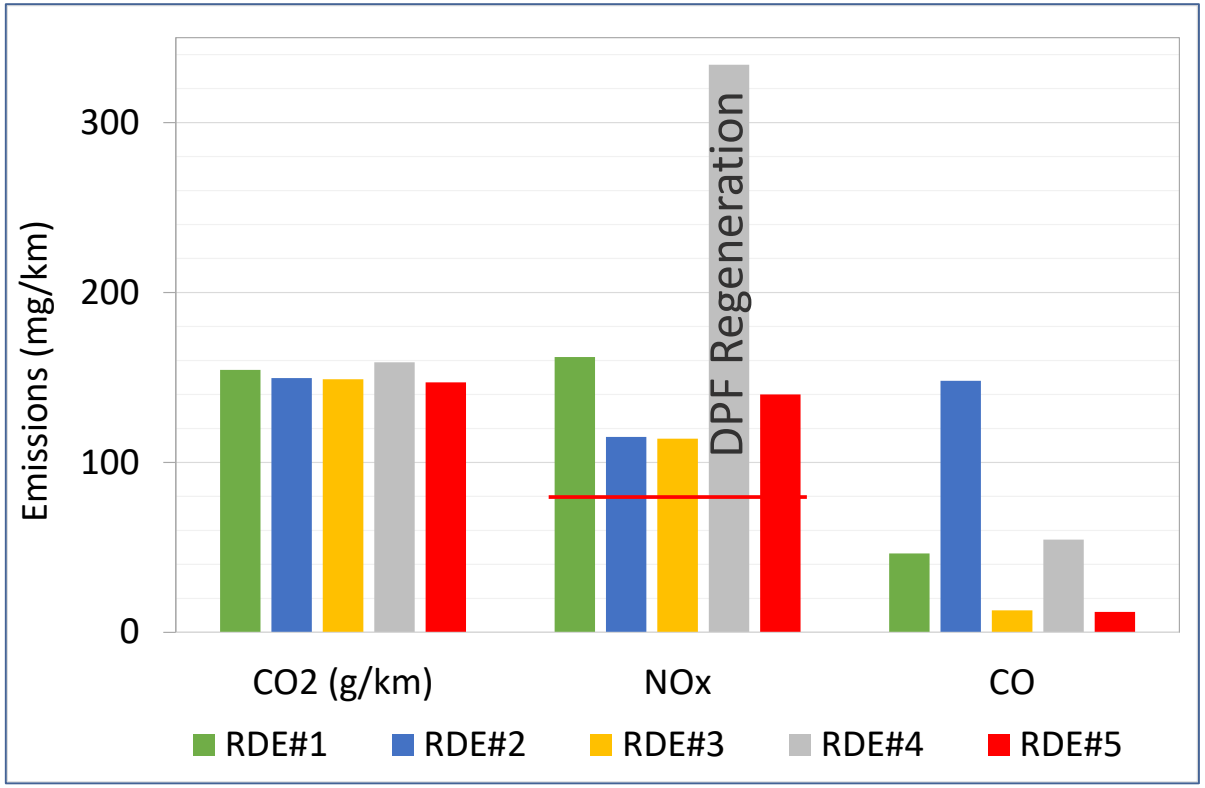


Source: AVL – Highly Efficient Exhaust Gas Aftertreatment for Future Diesel Applications – 10th International Exhaust Gas and Particulate Emissions Forum February 2018

AECC RDE test programmes demonstrated low emissions

- 2014: demonstrator with SCR on DPF
- 2015: series vehicle with SCR on DPF
- Results
  - NOx towards Euro 6d NTE (120 mg/km)
  - PN with DPF below $6x10^{11}$/km





2015 AECC series vehicle results:
PN & NOx emissions on RDE total

Bosch demonstrated urban RDE NOx below 80 mg/km

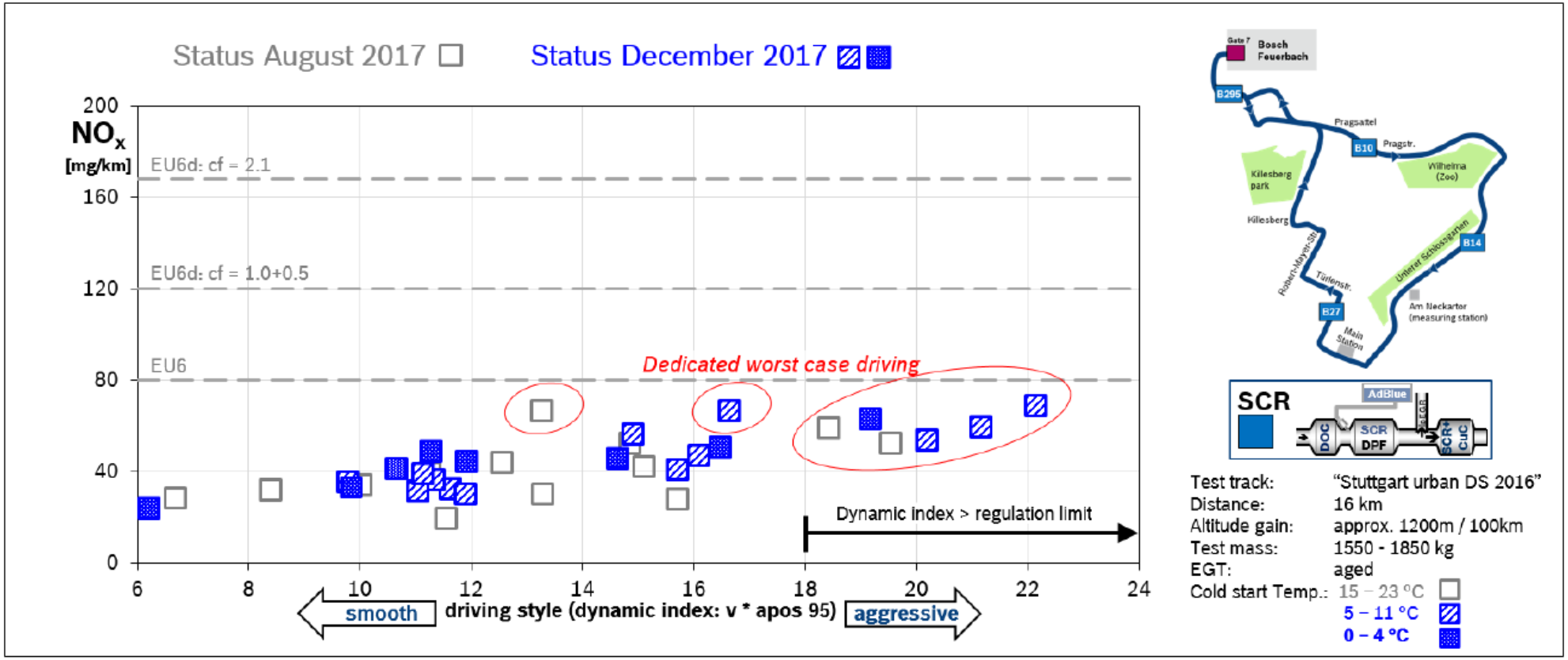


Figure 9: On-road measurements "Stuttgart – urban"

Source: Kufferath (Bosch), the path to a negligible NO_2 immission contribution from the diesel powertrain, Vienna Motor Symposium, April 2018

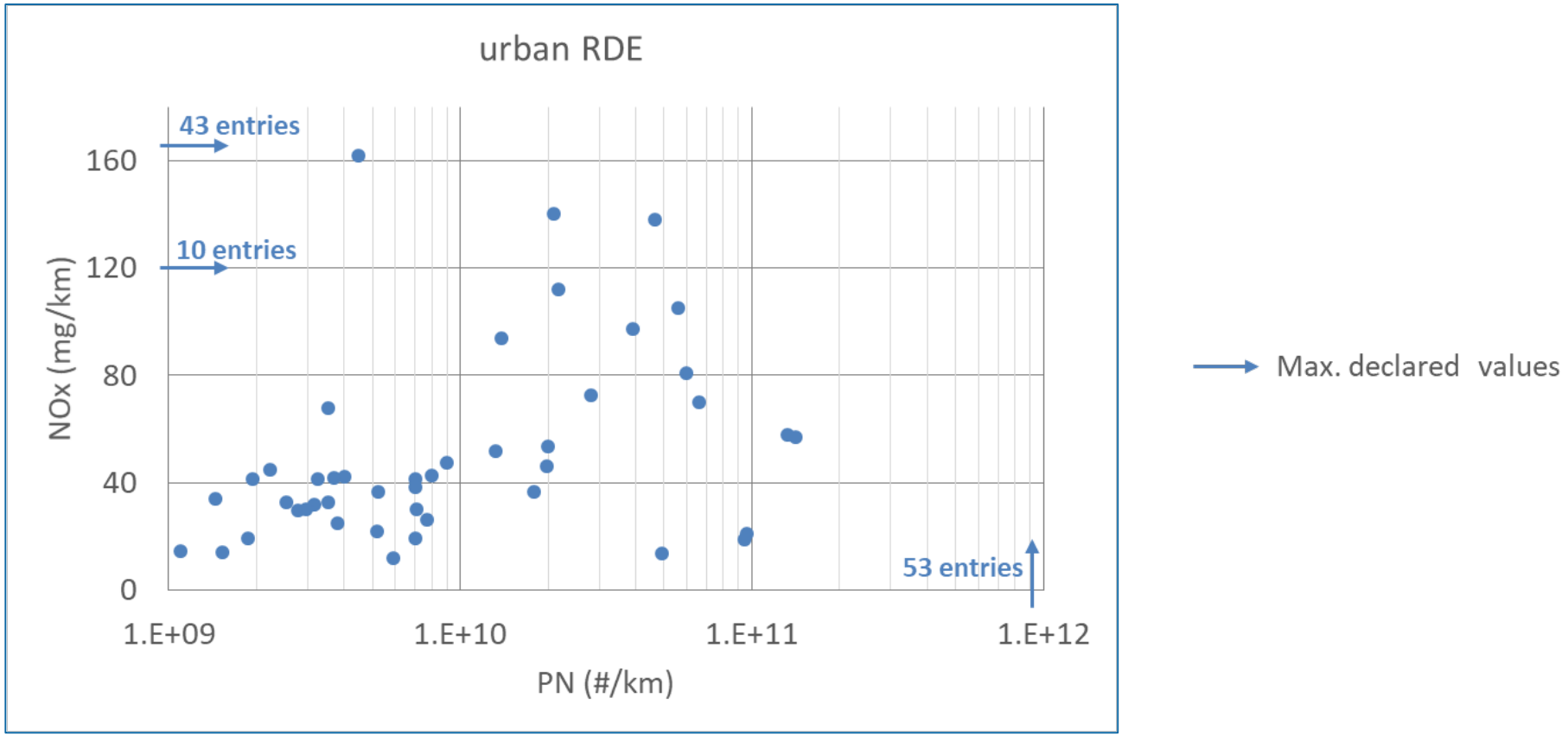
RDE-compliant cars (Euro 6d-TEMP) are available on the market

- List at www.adac.de/infotestrat/umwelt-und-innovation/abgas/modelle_mit_euro_6d_temp/default.aspx
- 569 models (on 12.06.18)
  - Incl. 224 diesel models

Marke	Modell	Motorart	Hubraum in ccm	Leistung in kW	Abgasnorm	Markt-einführung ab
Audi	A6 50 TDI	Diesel	2967	210	Euro6d-TEMP	Jun. 18
Audi	A7 Sportback 50 TDI	Diesel	2967	210	Euro6d-TEMP	Feb. 18
BMW	i3 (94Ah) (inkl. REX)	Elektro	647	125	Euro6d-TEMP	Apr. 18
BMW	i3s (94Ah) (inkl. REX)	Elektro	647	135	Euro6d-TEMP	Apr. 18
BMW	216i Active Tourer	Otto	1499	80	Euro6d-TEMP	Mrz. 18
BMW	218i Active Tourer	Otto	1499	103	Euro6d-TEMP	Mrz. 18
BMW	225xe iPerformance Active Tourer	Hybrid	1499	165	Euro6d-TEMP	Mrz. 18
BMW	216d Active Tourer	Diesel	1496	85	Euro6d-TEMP	Mrz. 18
BMW	218d Active Tourer	Diesel	1995	110	Euro6d-TEMP	Mrz. 18
BMW	220d Active Tourer	Diesel	1995	140	Euro6d-TEMP	Mrz. 18
BMW	216i Gran Tourer	Otto	1499	80	Euro6d-TEMP	Mrz. 18
BMW	218i Gran Tourer	Otto	1499	103	Euro6d-TEMP	Mrz. 18
BMW	216d GranTourer	Diesel	1496	85	Euro6d-TEMP	Mrz. 18
BMW	218d GranTourer	Diesel	1995	110	Euro6d-TEMP	Mrz. 18
BMW	220d Gran Tourer	Diesel	1995	140	Euro6d-TEMP	Mrz. 18
BMW	420i Coupé	Otto	1998	135	Euro6d-TEMP	Mrz. 18
BMW	430i Coupé	Otto	1998	185	Euro6d-TEMP	Mrz. 18
BMW	i8 Coupé	Hybrid	1499	275	Euro6d-TEMP	Mai. 18
BMW	i8 Roadster	Hybrid	1499	275	Euro6d-TEMP	Mai. 18
BMW	X1 sDrive18i	Otto	1499	103	Euro6d-TEMP	Mrz. 18
BMW	X1 sDrive18d	Diesel	1995	110	Euro6d-TEMP	Mrz. 18
BMW	X1 xDrive18d	Diesel	1995	110	Euro6d-TEMP	Mrz. 18
BMW	X1 xDrive20d	Diesel	1995	140	Euro6d-TEMP	Mrz. 18
BMW	X2 sDrive18i	Otto	1499	103	Euro6d-TEMP	Mrz. 18
BMW	X2 sDrive18d	Diesel	1995	110	Euro6d-TEMP	Mrz. 18
BMW	X2 xDrive18d	Diesel	1995	110	Euro6d-TEMP	Mrz. 18
BMW	X2 xDrive20d	Diesel	1995	140	Euro6d-TEMP	Mrz. 18
BMW	X3 xDrive20i	Otto	1998	135	Euro6d-TEMP	Dez. 17
BMW	X3 xDrive30i	Otto	1998	185	Euro6d-TEMP	Dez. 17
BMW	X4 xDrive20i	Otto	1998	135	Euro6d-TEMP	Apr. 18
BMW	X4 xDrive30i	Otto	1998	185	Euro6d-TEMP	Apr. 18
Citroen	C3 PureTech 68	Otto	1199	50	Euro6d-TEMP	Mai 18
Citroen	C3 PureTech 82	Otto	1199	61	Euro6d-TEMP	Mai 18
Citroen	C3 PureTech 110	Otto	1199	81	Euro6d-TEMP	Mai 18
Citroen	C3 BlueHDi 100	Diesel	1997	75	Euro6d-TEMP	Mai 18
Citroen	C4 Spacetourer BlueHDi 160	Diesel	1997	120	Euro6d-TEMP	Mai 18
Volvo	V60 D3	Diesel	1969	110	Euro6d-TEMP	Jul. 18
Volvo	V60 D4	Diesel	1969	140	Euro6d-TEMP	Jul. 18
Volvo	S90 T4	Otto	1969	140	Euro6d-TEMP	Mrz. 18
Volvo	S90 T5	Otto	1969	184	Euro6d-TEMP	Mrz. 18
Volvo	S90 T6	Otto	1969	228	Euro6d-TEMP	Mrz. 18
Volvo	S90 T8 Twin Engine	Hybrid	1969	288	Euro6d-TEMP	Mrz. 18
Volvo	S90 D3	Diesel	1969	110	Euro6d-TEMP	Mrz. 18
Volvo	S90 D4	Diesel	1969	140	Euro6d-TEMP	Mrz. 18
Volvo	S90 D5	Diesel	1969	173	Euro6d-TEMP	Mrz. 18
Volvo	V90 T4	Otto	1969	140	Euro6d-TEMP	Mrz. 18
Volvo	V90 T5	Otto	1969	184	Euro6d-TEMP	Mrz. 18
Volvo	V90 T6	Otto	1969	228	Euro6d-TEMP	Mrz. 18
Volvo	V90 T8 Twin Engine	Hybrid	1969	288	Euro6d-TEMP	Mrz. 18
Volvo	V90 D3	Diesel	1969	110	Euro6d-TEMP	Mrz. 18
Volvo	V90 D4	Diesel	1969	140	Euro6d-TEMP	Mrz. 18
Volvo	V90 D5	Diesel	1969	173	Euro6d-TEMP	Mrz. 18
Volvo	V90 Cross Country T5	Otto	1969	184	Euro6d-TEMP	Mrz. 18
Volvo	V90 Cross Country T6	Otto	1969	228	Euro6d-TEMP	Mrz. 18
Volvo	V90 Cross Country D4	Diesel	1969	140	Euro6d-TEMP	Mrz. 18
Volvo	V90 Cross Country D5	Diesel	1969	173	Euro6d-TEMP	Mrz. 18
Volvo	XC40 T3	Otto	1498	114	Euro6d-TEMP	Feb. 18
Volvo	XC40 T4	Otto	1969	140	Euro6d-TEMP	Feb. 18
Volvo	XC40 T5	Otto	1969	182	Euro6d-TEMP	Feb. 18
Volvo	XC40 D3	Diesel	1969	110	Euro6d-TEMP	Feb. 18
Volvo	XC40 D4	Diesel	1969	140	Euro6d-TEMP	Feb. 18
Volvo	XC60 T5	Otto	1969	184	Euro6d-TEMP	Feb. 18
Volvo	XC60 T6	Otto	1969	228	Euro6d-TEMP	Feb. 18
Volvo	XC60 T8 Twin Engine	Hybrid	1969	288	Euro6d-TEMP	Feb. 18
Volvo	XC60 D3	Diesel	1969	110	Euro6d-TEMP	Feb. 18
Volvo	XC60 D4	Diesel	1969	140	Euro6d-TEMP	Nov. 17
Volvo	XC60 D5	Diesel	1969	173	Euro6d-TEMP	Nov. 17
Volvo	XC90 T5	Otto	1969	184	Euro6d-TEMP	Mrz. 18
Volvo	XC90 T6	Otto	1969	228	Euro6d-TEMP	Mrz. 18
Volvo	XC90 T8 Twin Engine	Hybrid	1969	288	Euro6d-TEMP	Mrz. 18
Volvo	XC90 D5	Diesel	1969	173	Euro6d-TEMP	Nov. 17
VW	up! GTI	Otto	999	85	Euro6d-TEMP	Jan. 18
VW	Touareg 3.0 V6 TDI SCR	Diesel	2967	210	Euro6d-TEMP	Jul. 18

and many more …

Emissions of Euro 6d-Temp diesels well within standards



Source: PEMS results and maximum declared values from ACEA RDE database consulted on 26 April 2018

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- Evolution in diesel emissions control technologies
- Low NOx emission diesel cars: a reality
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Air quality modelling study done by IIASA up to 2040

Impact of Euro 6d/RDE legislation investigated for AECC

- Scenario = impact assessment of the EU's Thematic Strategy on Air Pollution
  - PRIMES, including Euro 6d
  - Extended for developments up to 2040

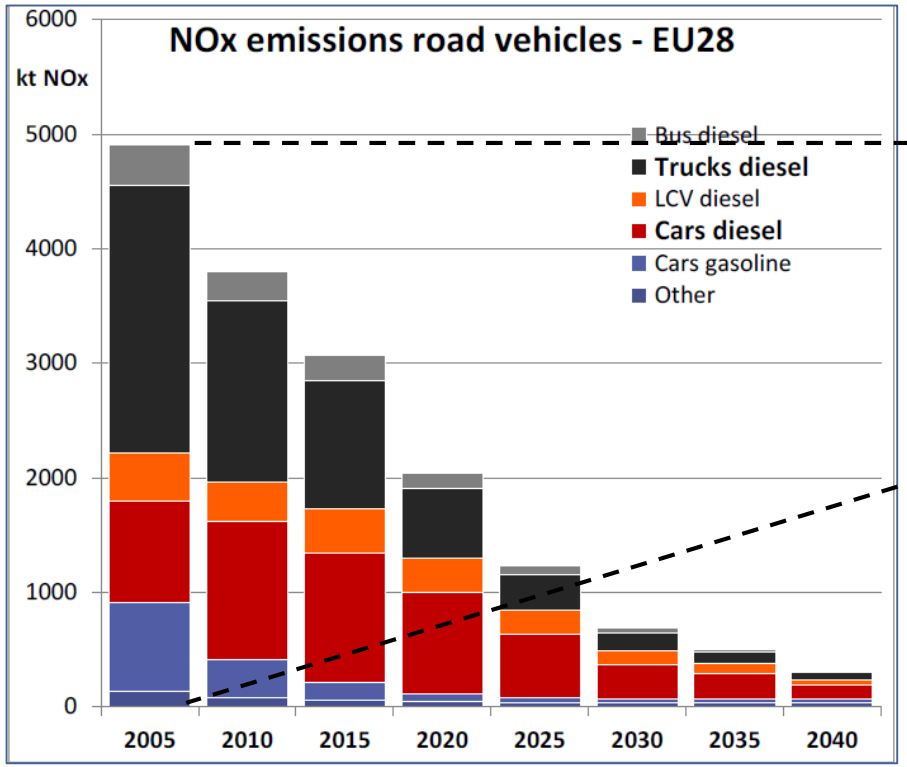
- Assumptions
  - Emissions factors = RDE Conformity Factors
  - Fleet turnover from COPERT model
  - NOx control tampering issues not included (e.g. AdBlue® emulator): effects?

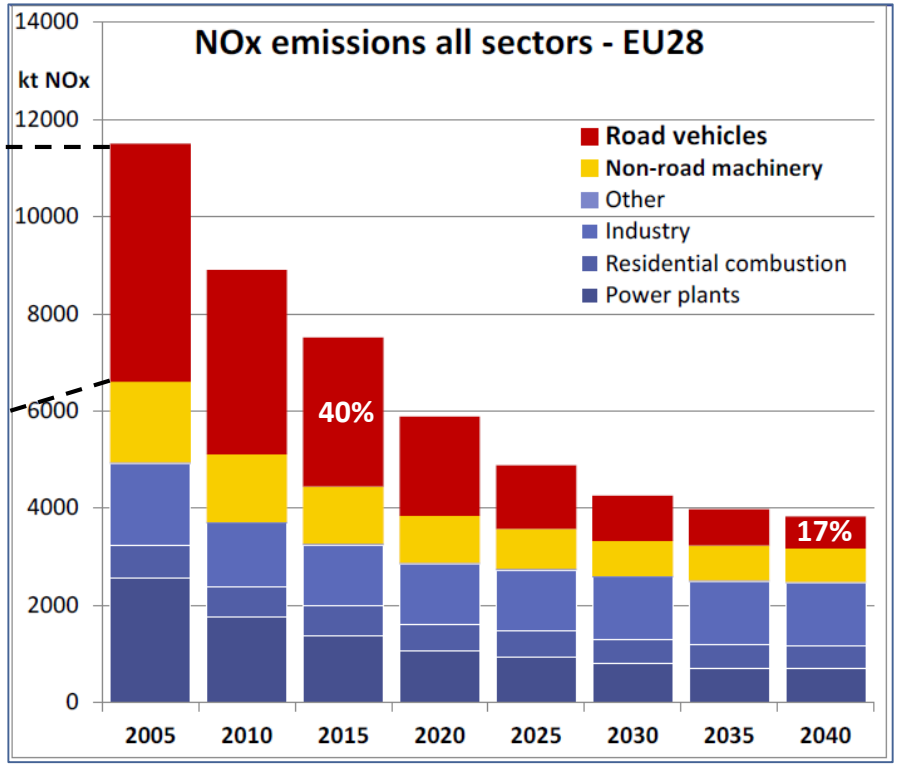
Average NOx emissions and share of primary NO_2 for diesel passenger cars

	average NOx emission rate in on-road driving [mg/km]	share of primary NO_2
Euro 4 and older	~600	range: 7% to 49%
Euro 5 – until 09/15	~750	37%
Euro 6b – 09/15-08/19	~350 (CF:4.4)	32%
Euro 6dTEMP – 09/19-12/20	linear combination of Euro 6b and Euro 6d	
Euro 6d – from 01/21	~120 (CF:1.5)	32%

Euro 6d benefit to EU NOx emissions inventory

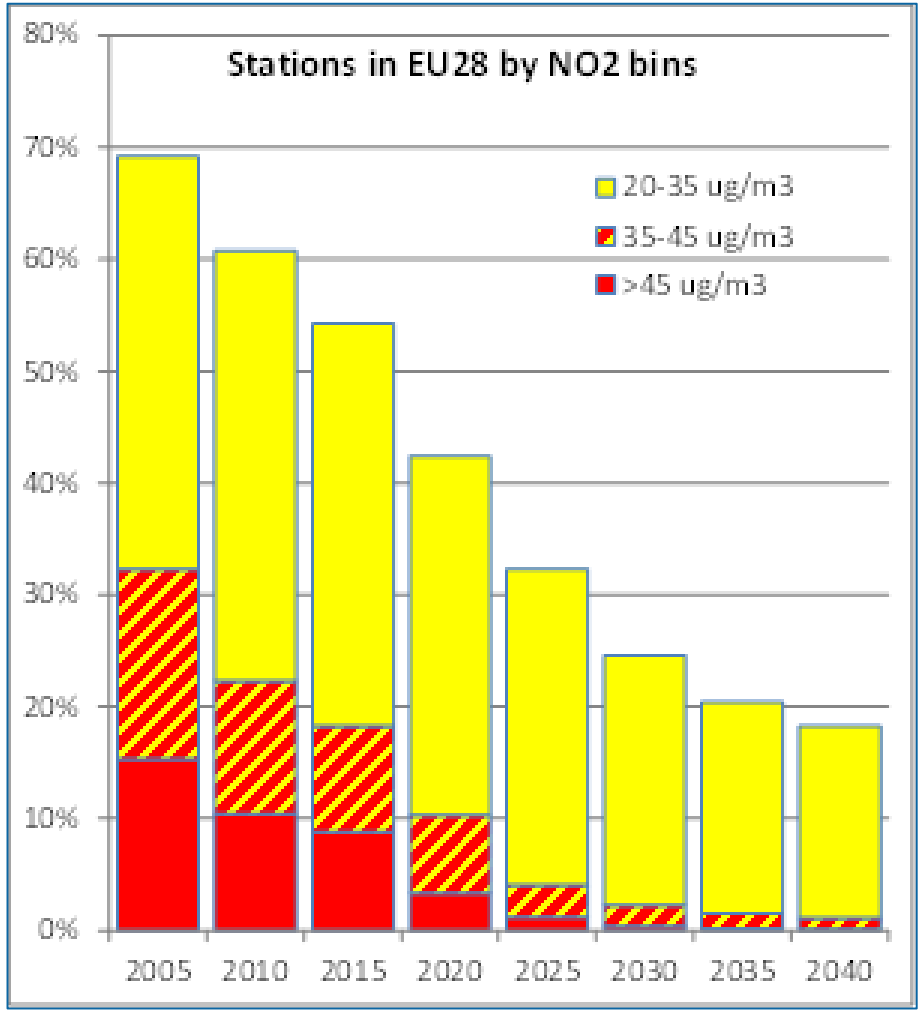
- Road vehicles contribution
  - 2015: 40%
  - 2040: 17% (provided Euro 6d Emissions Factors = Conformity Factors)





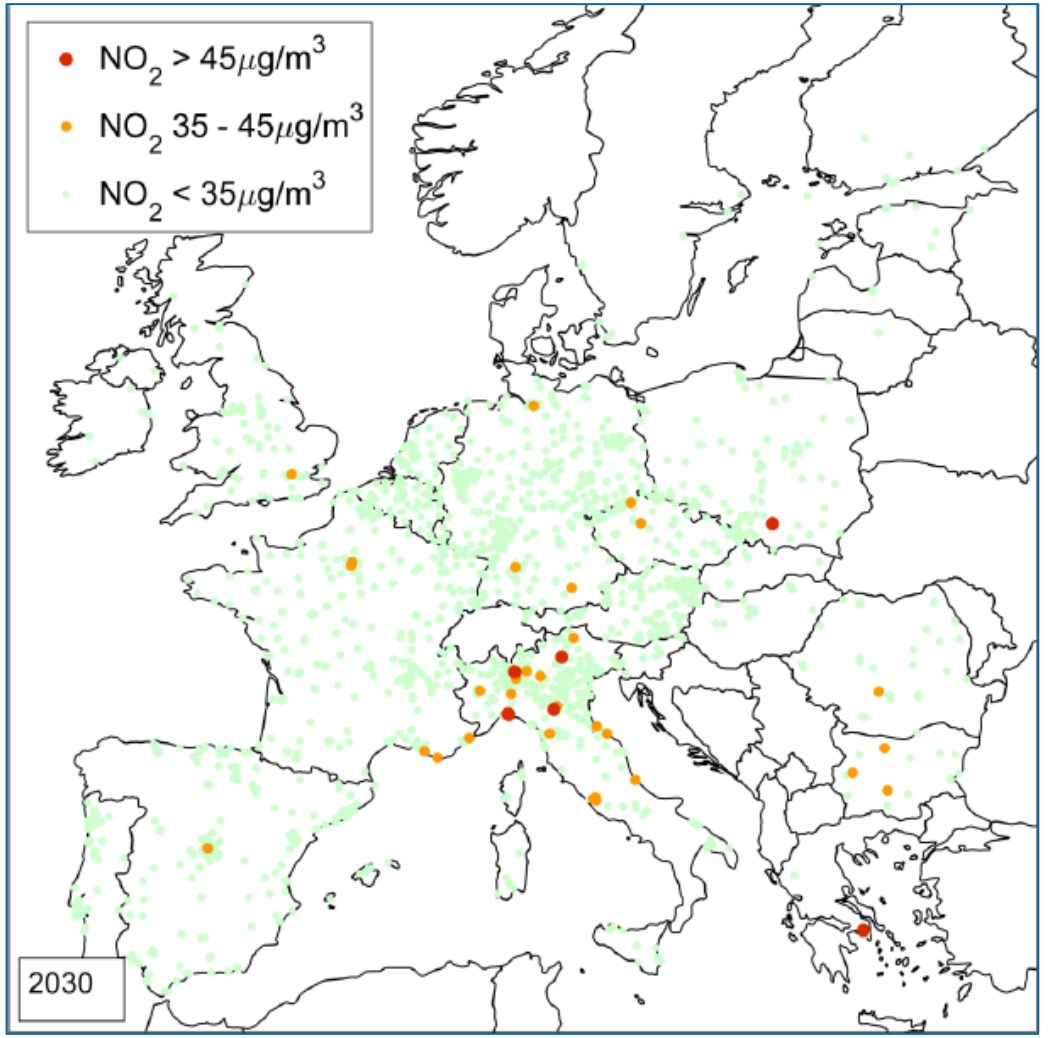
Euro 6d benefit to NO_2 monitoring stations exceedances

- WHO Global Air Quality Guideline for annual NO_2 concentration
  - Current guideline: 40 µg/m³
  - On-going review may lower the guideline value
- NO_2 exceedance classes modelled
  - Severe: >45 µg/m³
  - Problematic: 35-45 µg/m³
  - Potentially: 20-35 µg/m³
- Strong decline of number of NO_2 stations >35 µg/m³



Remaining NO_2 monitoring stations exceedances in 2030

- Cities (e.g. Athens, London, Paris, Madrid, Hamburg, Munich, Stuttgart)
- Areas with high industrial activity and bad air exchange (e.g. Northern Italy, Southern Poland, areas in Bulgaria and Romania)



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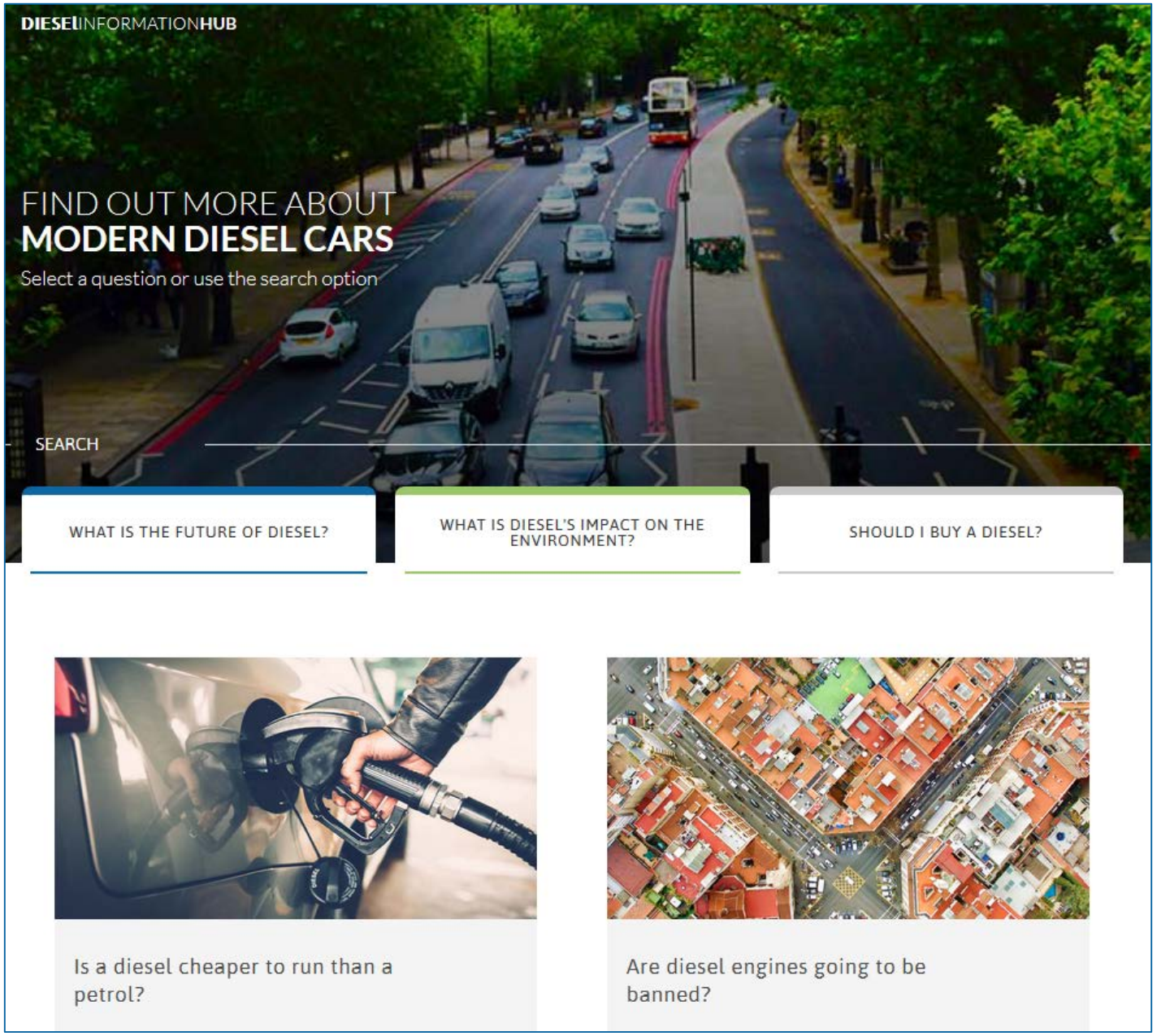
Conclusions

- A new era for vehicle emissions control started in September 2017 with introduction of RDE and WLTP.
- On-road emissions performance of RDE-compliant diesel vehicles are well within standards.
- Air quality simulation demonstrates that modern diesel engines are on the pathway to have a low impact. Contribution projected to be similar to other sources.
- Efforts will nevertheless continue to further reduce the impact of all sources.

Diesel information hub

Launched 15 May 2018

dieselinformation.aecc.eu



THANK YOU !

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